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USE OF SEAWEEDS IN THE CONTROL OF ROOT ROT-ROOT KNOT DISEASE COMPLEX OF OKRA

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ABSTRACT

Stokeyia indica, *Iyengaria stellata* (brown), and *Solieria robusta* (red) seaweeds showed significant ($p<0.05$) control of root infecting fungi *viz.*, *Macrophomina phaseolina*, *Rhizoctonia solani*, and *Fusarium solani* infection of okra roots. Use of *Stokeyia indica*, *Stoechospermum marginatum*, *I. stellata*, and *Solieria robusta* significantly ($p<0.05$) reduced gall formation on roots caused by *Meloidogyne javanica* root knot nematode. Maximum reduction was produced by *Stoechospermum marginatum* @ 1% w/w of soil. *Iyengaria stellata* used alone or with *Pseudomonas aeruginosa* plant growth promoting bacterium produced greater plant height.

KEY WORDS: seaweeds, algae, fungicide, nematicide, biocide

Exploitation of seaweed resources has attracted the attention of scientists all over the world because of their possible economic uses in various fields. Seaweeds contain all major and minor plant nutrients as well as biocontrol properties (Chapman & Chapman 1980; Shyamali *et al.* 1982). The wide varieties of marine algae have been found to possess useful biochemical compounds which have been studied as potential biocidal and pharmacological agents (Colwell 1983; Fenical 1982). Antimicrobial activity of seaweed has been reported (Febles *et al.* 1995; Hodgson 1984). Liquid concentration of brown seaweed *Ecklonia maxima* (Osbeck) Papenfuss significantly reduced root knot infestation and increased growth of tomato plants (Featomby-Smith & Staden 1983). Extract of *Ascophyllum nodosum* (Linnaeus) Le Jolis has been reported to reduce *Radopholus similis* infection on citrus (Tarjan 1977). Ara *et al.* (1997) also reported control of *Meloidogyne javanica* (Treub) Chitw. infection by *Sargassum* spp. on okra. *Pseudomonas aeruginosa* (Schroeter) Migula plant growth promoting bacterium (Izhar *et al.* 1995) is known to reduce root rot-root knot disease of chili (Siddiqui *et al.* 1999). Okra (*Abelmoschus esculentus* [L.] Moench), an important vegetable crop, is known to be attacked by root infecting fungi *viz.*,

Macrophomina phaseolina (Tassi) Goid, *Rhizoctonia solani* Kuhn, *Fusarium solani* (Mart) Appl. & Wollenw. emend. Snyd & Hans, and *F. oxysporum* Schlecht. emend. Snyd. & Hans (Ehteshamul-Haque & Ghaffar 1994) and root knot nematode (*Meloidogyne javanica*) (Maqbool 1992) in Pakistan. Experiments were therefore carried out to examine the effect of some brown and red seaweeds with or without *Pseudomonas aeruginosa* in the control of root rot-root knot disease complex of okra.

MATERIALS AND METHODS

Seaweeds viz., *Stoechospermum marginatum* (C. Agardh) Kutzing, *Stokeyia indica* Thivy & Dohshi, *Iyengaria stellata* (Borg) Borg (brown), and *Solieria robusta* (Greville) Kylin collected from Buleji, Karachi were washed, dried and powdered in an electric blender. Powdered seaweeds were mixed in sandy loam soil, pH 8.05 @ 0.5 and 1% w/w. The soil mixtures were transferred in 8 cm diameter plastic pots, 250 g per pot, which were watered daily and kept at 50% water holding capacity (Keen & Raczkowski 1921). The soil had a natural infestation of 4-13 sclerotia of *Macrophomina phaseolina* per gram of soil, as determined by wet sieving and dilution techniques (Sheikh & Ghaffar 1975), 5-12% colonization of *Rhizoctonia solani* on sorghum seeds used as baits (Wilhelm 1955) and 3300 cfu of mixed population of *Fusarium solani*, and *F. oxysporum* as assessed by the soil dilution technique of Nash & Snyder (1962). After three weeks, aqueous suspension of *Pseudomonas aeruginosa* (10^8 cfu/mi) multiplied on Nutrient Agar was drenched in each pot @ 25 ml/pot. Five seeds of okra (*Abelmoschus esculentus*) were sown in each pot. Each treatment was replicated four times and randomized on a screen house bench. Pots without seaweed or *P. aeruginosa* served as control. After germination four seedlings were left in each pot. One week old seedlings were inoculated with aqueous egg suspension of *Meloidogyne javanica* @ 2000 eggs/pot cultured on brinjal (*Solanum melongena* L.).

Plants were uprooted after six weeks growth and root knot index recorded on 0-5 scale (Taylor & Sasser 1978). Data on height and fresh shoot weight were also recorded. To determine the incidence of root infecting fungi, the method used by Short *et al.* (1980) was modified, in which roots were washed in running tap water, five 1 cm long root pieces from tap roots, surface disinfected with 1% Ca $(OCl)_2$ and placed onto Potato Dextrose Agar Plates containing penicillin (100000 units/liter) and streptomycin (0.2 g/liter). The dishes were incubated for 5 days and incidence of fungi were recorded. Data were analyzed and subjected to Factorial ANOVA (FANOVA), followed by Least Significant Difference (LSD) according to Gomez & Gomez (1984).

RESULTS

Use of *Stoechospermum marginatum*, *Stokeyia indica*, and *Solieria robusta* alone or with *Pseudomonas aeruginosa* significantly reduced gall formation on okra roots. Maximum reduction in gall formation (0.2) was produced by *Stoechospermum*

marginatum @ 1% followed by *Stokeyia indica* (0.5) as compared to untreated control (3.4) (Table 1).

Solieria robusta @ 1% showed complete control of *Macrophomina phaseolina* and *Rhizoctonia solani* infection on okra roots. Use of *Stoechospermum marginatum* and *Stokeyia indica* also produced significant ($p<0.05$) control of *M. phaseolina* infection. *Stokeyia indica* @ 0.5% used alone or where *Stokeyia indica* @ 0.5% and 1%, *Iyengaria stellata* @ 0.5% and *Solieria robusta* @ 1% were used with *Pseudomonas aeruginosa* produced complete control of *R. solani* infection. Use of *Stokeyia indica*, *I. stellata*, and *Solieria robusta* significantly reduced *Fusarium solani* infection (Table 2). Greater plant height was produced where *I. stellata* @ 1% was used alone or with *P. aeruginosa*. Maximum fresh weight of shoot was produced by *Stokeyia indica* used with *P. aeruginosa* (Table 1).

DISCUSSION

Seaweeds contain elaborate secondary metabolites that play a significant role in the defense of the host against predators and parasites which offers a potential novel approach to control populations of plant parasitic nematodes (Paracer *et al.* 1987). Growth inhibition of several bacteria and fungi by seaweed has been reported (Welch 1962). Febleo *et al.* (1995) reported antimicrobial activity of Canary species of Phaeophyta and Chlorophyta. Antimicrobial (Usmanghani & Shameel 1986) and cytotoxic activities (Ara *et al.* 1999) have been reported from Pakistan. Sheikh *et al.* (1990) isolated four diterpenoides from *Stoechospermum marginatum* which exhibited antibacterial and antifungal activities.

In the present study soil amendment with seaweeds significantly reduced *Macrophomina phaseolina*, *Rhizoctonia solani*, *Fusarium solani*, and *Meloidogyne javanica* infection on okra roots. There are reports that seaweed extract derived from *Ascophyllum nodosum* reduced the fecundity of the root knot nematode on tomato (Whapham *et al.* 1994). Soil amendment with *Sargassum* species significantly reduced infection of *Macrophomina phaseolina*, *R. solani*, and *F. solani* on sunflower (Ara *et al.* 1996). In the present study, in addition to reducing infection of root infecting fungi and root knot nematode, seaweeds also enhanced plant growth. The growth enhancement may be due to presence of growth regulators (Jeannin *et al.* 1991), like auxins, gibberellin and precursors of ethylene which have been detected in a number of seaweeds (Jolivet *et al.* 1991; Crouch *et al.* 1992) which improve vegetative and reproductive growth with an increase in seed production (Staden *et al.* 1994). Seaweeds could be exploited for the isolation of antifungal and nematicidal compounds for the control of root infecting fungi and nematodes affecting the vegetable crops.

Table 1. Effect of seaweeds on plant height, fresh weight of shoot and infection of *Meloidogyne javanica* on okra roots.

No.	Treatment	Plant height (cm)	Fresh shoot weight (g)	RKI
1.	Control	11.2	1.1	3.4
2.	*Pseudomonas aeruginosa* (Pa)	14.1	1.4	1.8
3.	*Stoechospermum marginatum* @ 0.5%	11.5	1.8	0.5
4.	*Stoechospermum marginatum* @ 1%	14.0	1.4	0.2
5.	*Stokeyia indica* @ 0.5%	13.9	2.0	0.5
6.	*Stokeyia indica* @ 1%	14.0	2.0	1.8
7.	*Iyengaria stellata* @ 0.5%	12.1	1.6	2.0
8.	*I. stellata* @ 1%	15.0	2.3	2.0
9.	*Solieria robusta* @ 0.5%	11.6	2.1	0.8
10.	*Solieria robusta* @ 1%	14.8	1.7	0.8
11.	*Stoechospermum marginatum* @ 0.5% +Pa	10.1	1.2	0.3
12.	*Stoechospermum marginatum* @ 1% +Pa	11.1	1.3	0.5
13.	*Stokeyia indica* @ 0.5% +Pa	12.5	2.8	1.2
14.	*Stokeyia indica* @ 1% +Pa	12.9	2.1	0.9
15.	*I. stellata* @ 0.5% +Pa	14.1	1.8	1.2
16.	*I. stellata* @ 1% +Pa	14.5	2.1	0.8
17.	*Solieria robusta* @ 0.5% +Pa	11.1	1.7	0.8
18.	*Solieria robusta* @ 1% +Pa	13.2	2.1	0.9
	$LSD_{0.05}$	2.6	1.0	1.2

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Table 2. Effect of seaweeds on infection of *Macrophomina phaseolina*, *Rhizoctonia solani*, and *Fusarium solani* on okra roots.

No.	Treatment	*M. phaseolina*	*R. solani*	*F. solani*
		infection %		
1.	Control	91	37	66
2.	*Pseudomonas aeruginosa* (Pa)	18	6	41
3.	*Stoechospermum marginatum* @ 0.5%	27	25	37
4.	*Stoechospermum marginatum* @ 1%	33	37	33
5.	*Stokeyia indica* @ 0.5%	27	0	18
6.	*Stokeyia indica* @ 1%	18	8	18
7.	*Iyengaria stellata* @ 0.5%	61	8	6
8.	*I. stellata* @ 1%	66	27	0
9.	*Solieria robusta* @ 0.5%	41	27	18
10.	*Solieria robusta* @ 1%	0	0	12
11.	*Stoechospermum marginatum* @ 0.5% +Pa	18	18	12
12.	*Stoechospermum marginatum* @ 1% +Pa	18	33	75
13.	*Stokeyia indica* @ 0.5% +Pa	50	0	33
14.	*Stokeyia indica* @ 1% +Pa	58	0	66
15.	*I. stellata* @ 0.5% +Pa	75	0	61
16.	*I. stellata* @ 1% +Pa	18	6	6
17.	*Solieria robusta* @ 0.5% +Pa	50	18	41
18.	*Solieria robusta* @ 1% +Pa	71	0	61
	$LSD_{0.05}$ Treatments = 26.8			
	$LSD_{0.05}$ Pathogens = 10.9			

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